Vol. VII OCTOBER, 1896 No. 10

The National Geographic Magazine

AN ILLUSTRATED MONTHLY

Honorary Editor: JOHN HYDE

Honorary Associate Editors

A. W. GREELY W J McGEE ELIZA RUHAMAH SCIDMORE

CONTENTS

WASHINGTON
PUBLISHED BY THE NATIONAL GEOGRAPHIC SOCIETY

Agents in the United States and Canada

The American News Company, 39 and 41 Chambers Street, New York
Paris: Brentanos, 37 Avenue de l'Opera

Price 25 Cents REPRINT $2.50 a Year

Entered at the Post-office in Washington, D. C., as Second-class Mail Matter.

THE

National Geographic Society

ORGANIZED, JANUARY, 1888

THE NATIONAL GEOGRAPHIC MAGAZINE

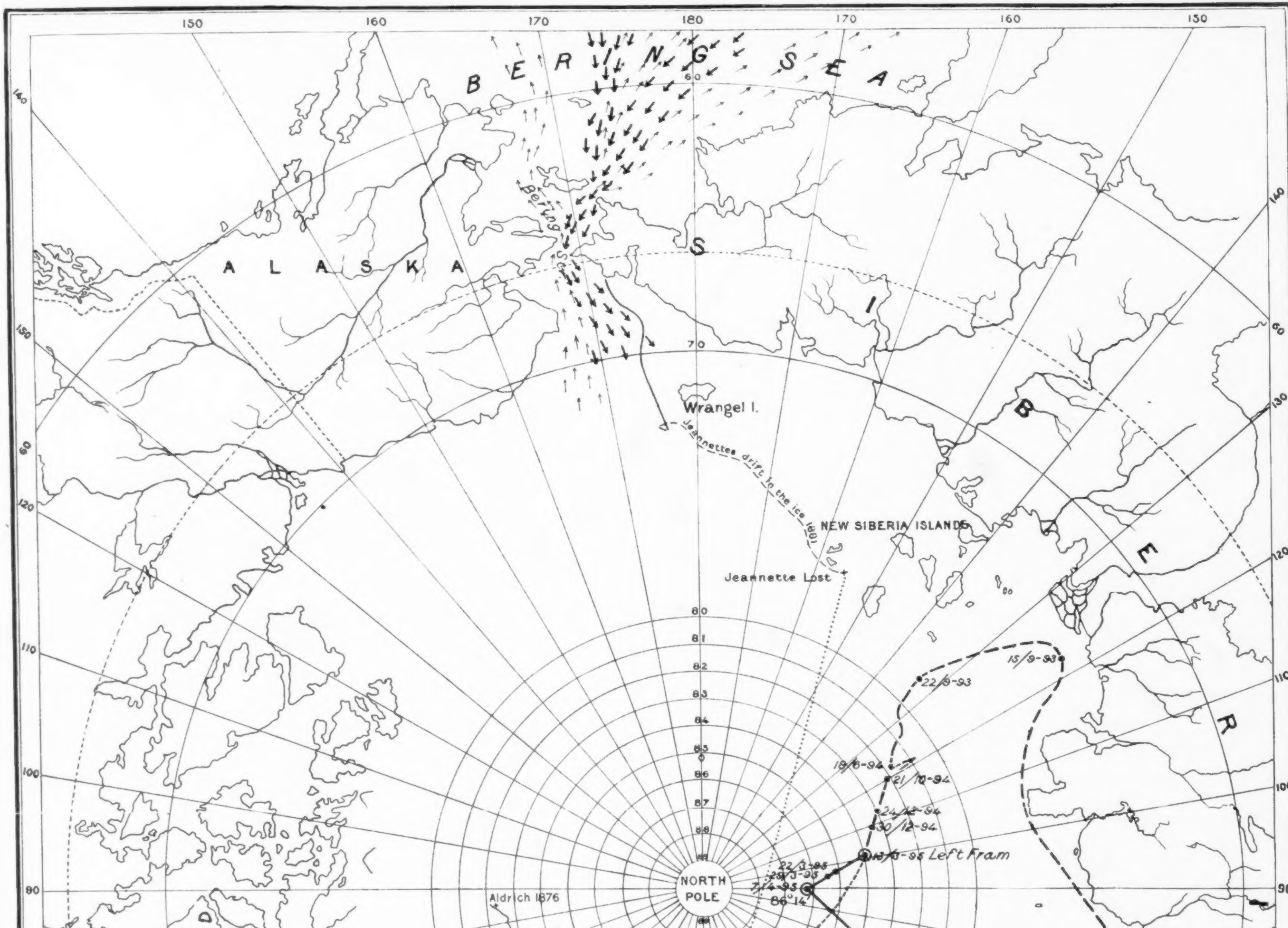
Back Numbers wanted by the Society.

For the purpose of making up complete sets of the Magazine, the National Geographic Society is prepared to purchase at reasonable prices the following back numbers :

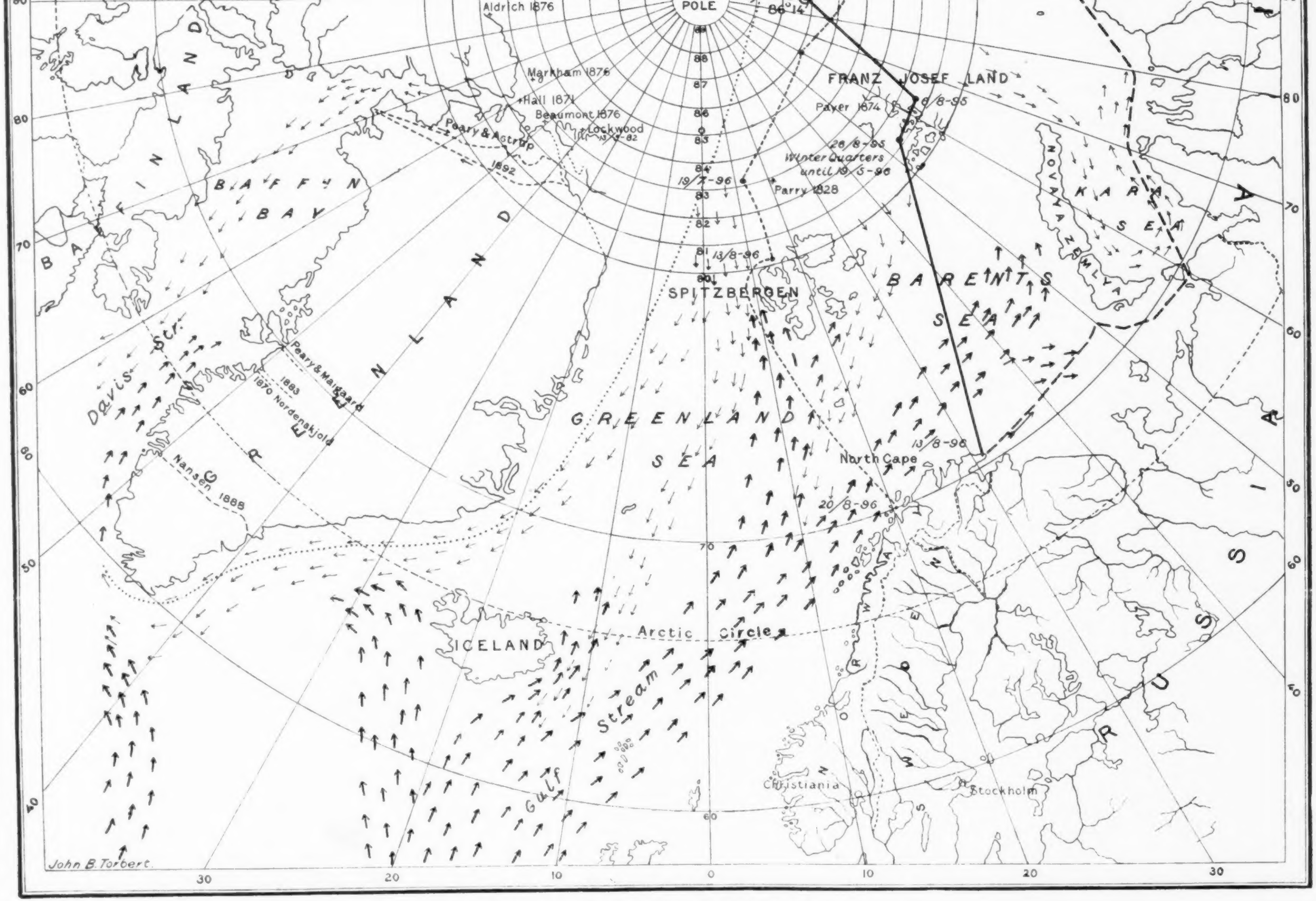
Of Vol. I, 1889, numbers 2 and 4; of Vol. II, 1890, numbers 2 and 3; of Vol. IV, 1892, numbers 1, 3, 4, 5, and 6.

Members of the Society or other persons having spare copies of any of these numbers are invited to sell or present them to the Society, as they may prefer.

Address: EVERETT HAYDEN, *Secretary*,
1517 H STREET, WASHINGTON.


BERING SEA
Bering St.
ALASKA
SIBERIA
Wrangel I.
Jeannettes drift in the ice 1881
NEW SIBERIA ISLANDS
Jeannette Lost
15/9-93
22/9-93
18/6-94
21/10-94
24/12-94
30/12-94
14/3-95 Left Fram
22/3-95
29/3-95
7/4-95
86°14
Aldrich 1876
NORTH POLE

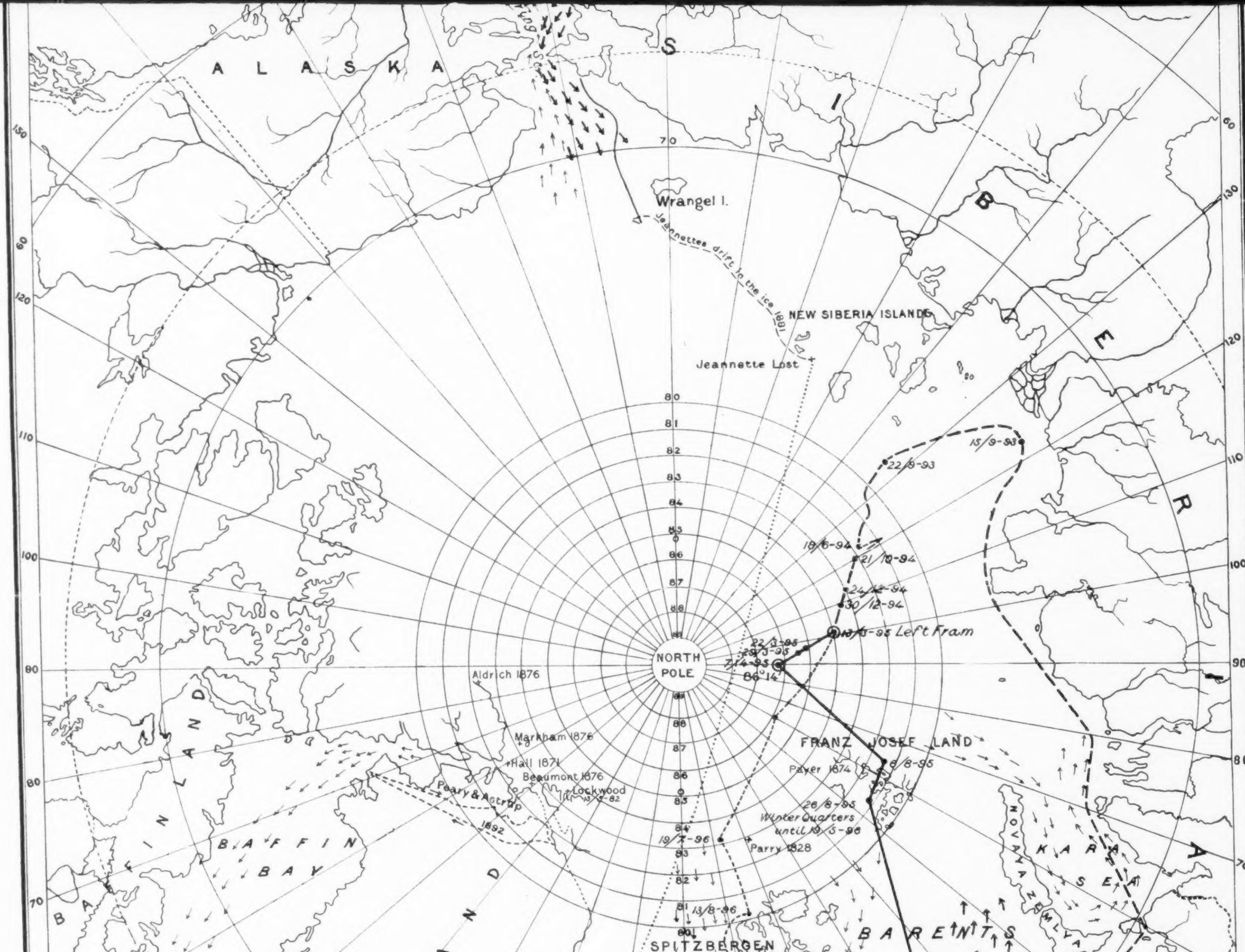
XUM

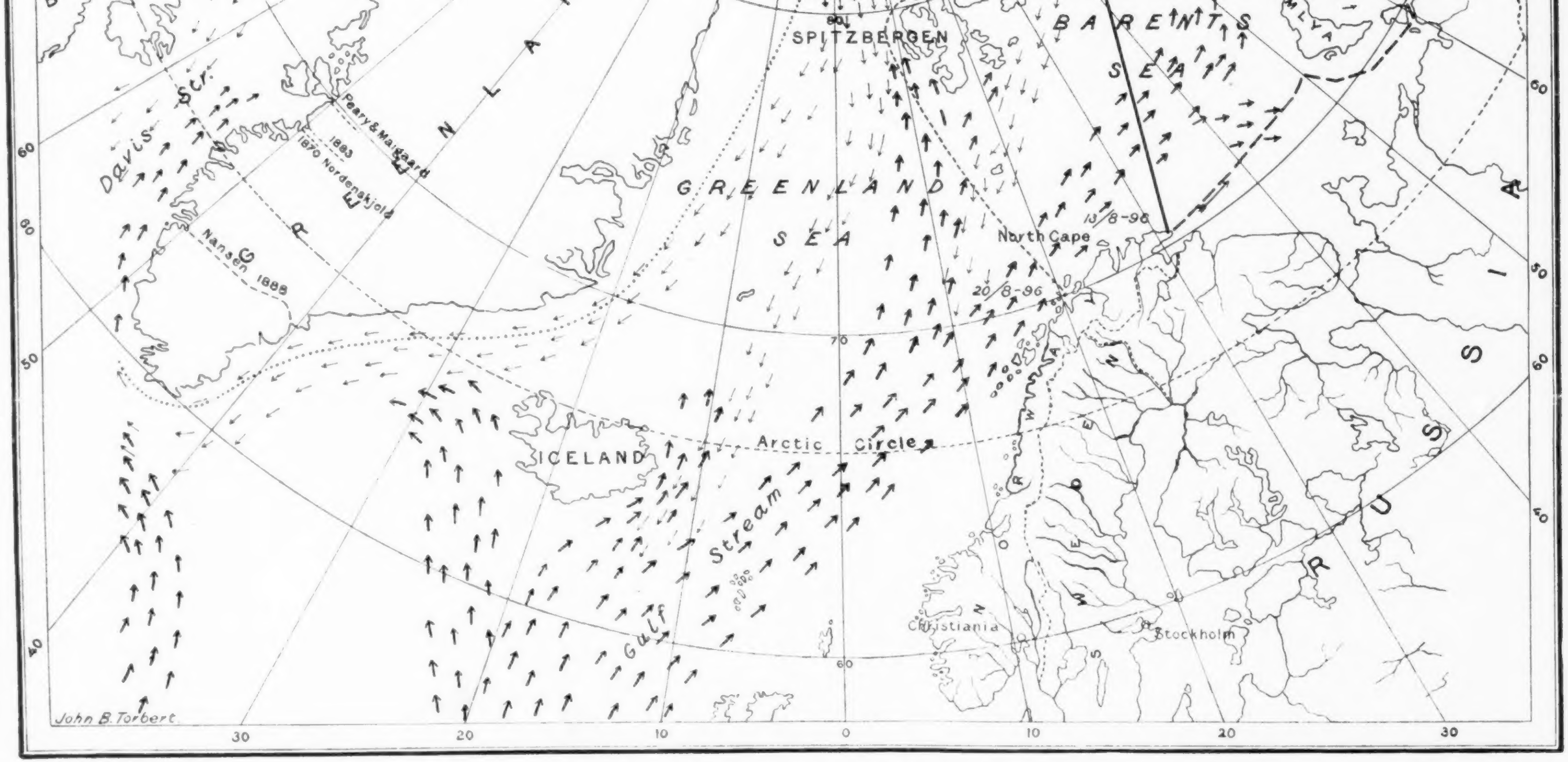


THE ARCTIC REGIONS

SHOWING ROUTES TRAVERSED BY THE NANSEN EXPEDITION

OF 1893-96


ALASKA
SIBERIA
Wrangel I.
Jeannettes drift in the ice 1881
NEW SIBERIA ISLANDS
Jeannette Lost
15/9-93
22/9-93
18/6-94
21/10-94
24/12-94
30/12-94
13/3-95 Left Fram
22/3-95
29/3-95
7/4-95
86° 14'
NORTH POLE
Aldrich 1876
Markham 1876
Hall 1871
Beaumont 1876
Lockwood
Peary & Astrup
1892
FRANZ JOSEF LAND
Payer 1874
6/8-95
26/8-95
Winter Quarters until 19/5-96
Parry 1828
19/7-96
13/8-96
SPITZBERGEN
BARENTS
KARA SEA
NOVAYA ZEMLYA
BAFFIN BAY
BAFFIN LAND
GREENLAND



THE ARCTIC REGIONS

SHOWING ROUTES TRAVERSED BY THE NANSEN EXPEDITION

OF 1893-96

— — — — Route of Fram up to the time Nansen left for his dash towards the Pole

- - - - - - Route of Fram after Nansen's departure

———— Nansen's route after leaving Fram

·········· Nansen's idea of route of supposed Jeannette relics

→ → → Warm currents

← ← ← Cold currents

THE
National Geographic Magazine

Vol. VII OCTOBER, 1896 No. 10

CALIFORNIA

By the Hon. George C. Perkins,
United States Senator

The Californian is never at a loss for some good words for his state. If he is a pioneer he has wrought at the foundations and rejoices in the rise and progress of a commonwealth having now more than fourteen hundred thousand people. The Argonaut did not much concern himself with the geographical greatness of the future state. He did not even know that there would be a state. There was the great outlying territory of Alta California, stretching along for more than nine degrees of latitude and broadening inland to the crests of the Sierra 250 miles or more, an area that today contains 156,000 square miles, or more than 99,000,000 acres, constituting the second largest state in the Union. He knew little of the coastline, with its indentations a thousand miles in extent, as he sailed into that magnificent bay after his voyage around cape Horn, and he knew less if, after the long trail overland, he looked down from the top of the Sierra on the great valleys that lay between the mountains and the ocean.

The Spanish dominion, which lasted for 53 years, did not concern him much, since it left few vestiges of civilization. Mexican rule in Alta California was little more than a continuation of that of the mother country. The missions founded by the Catholic fathers constituted a chain of settlements from the bay of San Diego to the northern limit of the bay of San Francisco, each one making a little garden spot in the uncultivated waste. They founded no towns and built no cities. These missions in the height of their prosperity contained 24,000 Indian neophytes, possessing several hundred thousand cattle, 135,000

sheep, and 16,000 horses, and harvesting annually about 75,000 bushels of grain. Their decadence began when they were secularized by the act of the Mexican Congress, and that decline has not been arrested to this day. In the solitary places near where the fathers wrought there are now flourishing towns and cities, and the picturesque ruins of these old missions are among the treasures of the land.

The new era in the history of California began on July 7, 1846, when the American flag was hoisted at Monterey by Commodore Sloat. The discovery of gold followed on January 19, 1848, a month before the treaty of Guadalupe Hidalgo was signed and five months before Americans had acquired their title to California. Henceforth there were to be a new people, new laws, and new institutions. A few months after the discovery of gold 20,000 pioneers started on the long overland journey from the banks of the Missouri to California. Five thousand fell by the way through disease and hardships or were slaughtered by Indians. Scarcely less than 20,000 went by water, either around cape Horn or by way of the isthmus of Panama. In a few months 100,000 Argonauts were in California. Twenty-five years after that date $1,000,000,000 of gold had been taken out of the mines of the state. A stream of gold was poured into the Federal Treasury during the civil war, and there was another blessed outflow into the treasury of the sanitary commission for the relief of friend and foe alike, of the Gray as well as of the Blue.

For the first twenty years in the history of California the only mode of transportation after leaving the navigable rivers and the coast, aside from walking, was by stagecoach, wagon, pack-mules, and broncho horses. In Sacramento and Marysville, the two principal steamboat landings, it was a daily occurrence to have depart at break of day fifty or more stagecoaches and wagons loaded with passengers bound for the different mining towns and camps in the foothills and mountains. The return stages were so scheduled that they arrived back late in the afternoon or evening, and, with fresh exchange of horses, would be ready to leave again the following morning.

The early stage-driver in California was perhaps the most unique and was certainly one of the most important personages in the community. His social standing and influence were rated in about the following ratio: For a two-horse stage-driver to those of the sheriff; a four-horse stage-driver to a member of the legislature; a six-horse stage-driver to a mayor or governor,

while the driver of an eight-horse stagecoach upon a popular route through several flourishing mining camps would not have surrendered his place, with its influence and dignity, for a seat in either house of Congress. The teamster also was a very important personage, and the driver of an eight- or ten-bell mule team, with a single line, considered his position and importance quite equal to those of the superintendent of a railroad. I speak advisedly, for I have been honored with the experience.

Many of the richest mining camps could be reached only by long and circuitous routes, following up the forks and branches of rivers and creeks or over pathless hills and mountains. There being no roads or trails, the only manner in which supplies of provisions, clothing, and tools could be sent into the camp was upon pack-mules. These animals were loaded down with from 250 to 400 pounds of freight, which they carried upon their backs with apparent ease, crawling around steep points, over sliding earth and rock, where it seemed almost impossible for a man to walk. The pack-trains numbered from 50 to 100 mules in a train, each one in a single file, following the "bell leader," which was usually a broken-down, white horse that carried no load, and was directed by the owner of the pack-train, who also had a half-dozen or more Mexican vaqueros to assist in loading and unloading the mules; these brought up the rear of the caravan and saw that none of the train stopped by the way. Arrived at its destination, the cargo of freight was delivered at the mining camp, and the return train took back to the valley letters for the dear ones far away and gold dust to the merchants to pay for the merchandise and freight.

But no prosperous state was ever built over gold and silver mines. These were only a single element of future prosperity. The Argonaut had not come to build, but to find treasure for another and, as he thought, a better land; but these men were unconsciously making ready for the new commonwealth. Civilization could not survive without the state. There must be law and order, security for life and property. There must be organized society, or there would be chaos. Then the pioneers became builders. The bad element must be restrained and the good must have protection. There could be no permanent society without homes. California was no longer a barren land. Pioneers here and there had cultivated a few acres as a sort of heartsease. They had begun to make places beautiful as the garden of the gods. The land seemed to look up and smile when

touched by the various implements of cultivation. There was verdure in the desert. Wheat was no longer brought from Chili for bread. The wheat-fields of California began to wave in the morning and evening breeze.

The discovery of the agricultural capabilities of California was greater than the discovery of gold. Men ceased to talk about a worthless country. The land was vital with the elements of hidden fertility. There came a day when six hundred ships were not enough to carry the surplus wheat crop of the state to foreign lands. The whole country from not producing sufficient to feed 100,000 Argonauts at home was now producing enough to feed more than a million people abroad, and the capacity of the state today is sufficient to sustain ten millions.

Nor has the mineral industry become obsolete. If the testimony of mining experts is to be taken, there is more gold in the placers and quartz mines of the state than all that has ever been taken out; but the products of agriculture, of which there was once no promise, have annually for more than ten years past exceeded in value one hundred million dollars, although they have as yet reached only the first stage of development, while the annual production of gold and silver amounts to less than twenty million dollars.

But these are not all the marvelous industrial changes that have been wrought. The Mission Fathers adopted a primitive system of agriculture. They selected stations near the ocean, where the moisture was greatest and where there were living streams for artificial irrigation. They cultivated no crops that they could not water when the rains had ceased. They brought the olive and the vine from Spain and naturalized them in their gardens. The orange from Seville also sometimes bloomed and fruited there, but there were no blossoming orchards beyond, and no vineyards ripened the grape under the long summer sun. The native Mexican cared for none of these things; he was content with his jerked beef and his tortillas. Fruit was reserved as the luxury of those who cultivated it in consecrated gardens. It has been recorded that many a pioneer was ready to exchange a silver dollar for an apple. The orchard and the vineyard became a necessity. What was good in the old homestead ought to be good about the new one. Seeds were sent in letters; cuttings and small fruit trees came as the most precious freight of the early steamers by way of the isthmus. Orchards began to blossom in the valleys, and the vine made many little patches

of green on the hillsides. The wild vine was found climbing many a tree in the ravines and along the brooklets of the Coast range, and it could not be otherwise than that better ones would take kindly to the soil and give abundant fruitage. The best were brought from Spain and the wine districts of southern France. The mongrel and foxy grapes that suited eastern palates did not win any place in the viticulture of the state. The motto of the Californian everywhere is, "Get the best." After the vineyards of Spain and France had been laid under contribution, princely Tokays and mellow Muscats, with more than twenty other semitropical varieties, began to crowd the home markets. The wine grape climbed the hills and made the claret that was sold under a French label to thousands of eastern consumers. Eighteen million gallons of wine were the product of a single year. Grapes from these vineyards were shipped to every large city of the Union. More than 150,000 acres are now covered with vines in California, and the average product for an acre is nearly double the average product of the vineyards of France and Spain. For many large areas the average product is 12,000 pounds an acre, while in special instances the product reaches 20,000 pounds per acre. Beyond all other states of the Union, California is the land of the vine. More than two-thirds of the arable land of the state is suitable for viticulture and other fruit culture. There is more land in this one state suitable for the production of raisin grapes than there is adapted to that culture in Spain. When the Muscat began to hang in golden clusters and to turn into raisins on the vines, there was the first suggestion of the great raisin crop that could ultimately supply every market of this country. That the raisin product now falls short of this is because of the keen competition with the crop of Spain, that is produced for less than one-half the outlay for labor that the same production costs in California; but layer for layer and box for box, these domestic producers challenge for quality the best in the world. A small industry became a great one by beneficent protection. More is the pity that any part of it should have been withdrawn until these pioneers had fought out the battle for every home market in the land. The raisin product of the state last year was not less than 54,000,000 pounds. Not only is California golden-sandaled, but the very sun in the heavens turns her fruits into gold.

Such a miracle of transformation was wrought in southern California as had not been witnessed beyond her borders. The

dry land that had become dust under the hoofs of famishing cattle took on perpetual verdure when the streams were trailed over it, and the orange blossomed and fruited under a semi-tropical sun. Towns sprang up and cities were built largely from the proceeds of this citrus industry. Water was impounded in the mountains or was recovered from sunken streams in the plains. The desert became more than a garden. A great citrus product soon to rival that of Florida was the promise of the future. How has it been fulfilled? More than 8,000 carloads of oranges were shipped overland as the product of the season of 1894–'95. Not less than 14,000 acres have been planted with lemon trees, with the certainty that when the maximum of this branch of citrus culture shall have been reached, this fruit will compete for the first place in all the leading home markets of the United States. Of deciduous fruits altogether 4,435 carloads were shipped overland in 1895.

The olive took kindly to the soil. There was, in fact, no product of Spain or of any other country about the Mediterranean that could not be duplicated in California. The fig ripens as it does about the borders of the Adriatic, while of prunes more than 32,000,000 pounds represent the annual production of the state. With wine to make his heart glad, oil to make his face to shine, and honey to sweeten his lips, the Californian may speak with enthusiasm of all this wealth of resources. Then there is $100,-000,000 invested in the dairies of the state, and 40,000,000 pounds or more represents the beet-sugar product of the state for the season of 1894–'95—an amount larger than the aggregate production of all the rest of the country.

Passing from these details of production, it remains to be noted that California is the most picturesque state in the Union. This wealth of scenery can never be obscured. There is the great Sierra range stretching along the eastern boundary for 500 miles, having a width of 70 miles and summits ranging from 7,000 to more than 14,000 feet. Nineteen of these mountain peaks rise to the height of 10,000 feet, and seven of them rise still higher, until mount Whitney wears the crown, rising into the heavens to the height of 14,900 feet. Some of these summits are still warm with volcanic heat. There they stand, white-hooded, with glaciers moving and grinding along their flanks, as if a thousand years were but as yesterday, letting loose the mountain streams that go singing down to the sea. There is the divine sculpture of the rocks, the lakes that mirror these eternal ramparts, the

great forests that sing in storm and sigh in the summer breeze, and the groups of sequoia overmatching in height and circumference any other conifers on the globe. There the clouds come down and kiss the mountains, and the lesson is renewed every day of eternal repose and majesty and strength. There is the fir tree with its balsam, clean and sanitary, inviting the invalid to come for his healing; there are the cedars more stately than those of Lebanon, and pines that were dropping their cones long before the first white man had set foot upon the continent.

How little of all this reserve of natural wealth can be set forth by inventory or speech! Hardly an impression has been made on these virgin forests. There is the great sanitary district, free from dust, with pure water flowing out of the granite, and an atmosphere as sweet as the breath of heaven. These mountains are not solitary, but are rich in floral and animal life. There butterflies flit, and birds sing, and huge grizzly bears come out of caves and caverns. There the mariposa lily unfolds its petals, and the snow plant, red as blood, springs in a day mysteriously out of the margin of the receding banks of snow. There the lakes repose in bowls with mountains for rims. There, 8,000 feet above the level of the sea, is lake Tahoe, more than 20 miles long and 1,500 feet deep, and more than five hundred lakelets mirror the frowning battlements that rise above them. Here are the great reservoirs that send their waters down to fertilize the hot valleys below. More than 4,000,000 acres of land are irrigated by these mountain streams, and made among the most productive in the state. Millions more will be watered from the great reservoirs that are held in check by these great forests, so that there is neither wasting flood nor withering drought.

In that great mountain range there is one of the seven wonders of the world. From the ends of the earth men come to see the awful grandeur of Yosemite, which no artist can paint and no pen can adequately describe. They will look up to the mighty fall which, in three leaps, descends 2,600 feet to the floor of the valley. They will see the great Vernal and Nevada falls pouring out their mighty floods into the valley below. Standing on the floor of this valley, 4,060 feet above the level of the sea, the tourist looks up to these granite walls, varying in height from 1,200 to 4,600 feet, hears the roar of the great cataracts, sees the awful battlements where in the winter the snow banners float from their tops; sees the Bridal Veil floating over a vertical wall and falling for nearly a thousand feet; watches the rainbows as

they are set in this veil by the slant rays of the setting sun, and walks through this valley of wonderland six miles long, himself wondering whether by some mighty convulsion of nature the crust of the earth has fallen sheer down 4,000 feet, cleaving the granite on either side as it went, or whether the glaciers have plowed and eroded, planing and polishing the granite on either side, until Yosemite today is one of the sublime spectacles of the world. Cathedral spires and domes are there for his worship and the meadows are carpeted for his coming. Out of the valley a little way he will come upon groves of sequoia, the largest of which he will find by actual measurement to be 350 feet high and more than 30 feet in diameter. Away to the north in the same great Sierra range is mount Shasta, 14,442 feet high, wearing its eternal mantle of white as if set there as a great white throne for the coming judgment of the world.

Nor does this wealth of the picturesque end here. There is the Coast range that rims the great valleys on the ocean side, broken here and there, but extending parallel with the Sierra for hundreds of miles. For a part of the way there is an inner coast range inclosing such beautiful valleys as the Santa Clara, Sonoma, and Napa, presenting a series of landscapes that are unsurpassed on the Pacific coast for quiet picturesque effect. Here the apricot and the prune come to perfection, and the vineyards that creep up the mountains, in some places to their summits, produce the most luscious of all the table grapes that are sent late in the season to New York and other eastern markets.

It is in that part of the Coast range extending from Monterey bay to the northern border of Mendocino county (a distance of about 300 miles and averaging about 25 miles in breadth) and only there in the whole world that the redwood, *sequoia sempervirens*, is found, the first in commercial value of all the trees in California and, for the area covered, probably the most valuable timber tree in the United States. It belongs to the cedar family, lacking the pungent odor of the white cedar, but surpassing all others of this family in symmetry of form and in size, which, in some instances, is but little less than the related species, the *sequoia gigantea*, which is found nowhere else but on the western slope of the Sierra in isolated groves at elevations of from 3,000 to 5,000 feet. These redwood trees frequently attain an elevation of 200 feet and a diameter of from 10 to 12 feet. The average is something less. During the past season a redwood tree, yielding 48,000 feet of merchantable lumber, or a full cargo for

a schooner of 125 tons, was cut by a lumberman in Mendocino county. One of the redwood trees, known as the Frémont tree, in the group near Santa Cruz, is 275 feet high and is 19 feet in diameter six feet above the ground. In the hollow of this tree a family some years ago found a comfortable residence for an entire winter. It was in or near this grove that Frémont encamped before the conquest of California had been fully made. This great timber district is within the humid belt of California, and all the picturesque valleys that extend along the base of these wooded mountains have a network of living streams that find their way to the sea. The valleys are dotted with beautiful towns and the landscape is a succession of vineyards and orchards. This redwood, besides its extensive use for the interior finish of houses, is everywhere admired for its natural color tones and is now in quest by Europeans for ornamental use. The pine and the fir tree, so common in California, are denizens of many countries, but the redwood makes here the one exclusive timber belt of its kind in the world.

The Sierra and the parallel Coast range inclose the great and continuous valley of the San Joaquin and the Sacramento, 350 miles long and with a breadth of about 40 miles, making an aggregate area of about 14,000 square miles. Forty-five years ago the greater part of the land in the San Joaquin valley could have been bought at $1.25 an acre. Thirty-five years ago there were thousands of acres which the Government had offered at the minimum price that found no buyers. The parched and desolate valley lay there at the base of the mighty Sierra, adown which the mountain streams descended, but made no fruitful fields. Today there are flourishing cities and towns, vineyards and orchards, and great wheatfields. From that valley enough raisins were produced this year to supply two-thirds of the consumption of the whole country. From this and the related valleys 9,000 carloads of oranges and 400,000 cases of lemons will this season go forward to Eastern markets. Add to this product not less than 4,000 tons of raisins, and we come to see the relation of all this wealth of production of the great mountain ranges which send their streams down to fertilize this great valley. From the hot plains men look up to these snow-clad mountains and know that the reservoirs will never fail, and that the winter gales that sing in the tops of the fir trees and smite the giant sequoia serve best to make eternal spring in the valley below. The San Joaquin from the south and the Sacramento from the

north flow through the length of these valleys and enter the northern end of the great bay of San Francisco, an inland water 35 miles long and averaging 8 miles in breadth. There great navies ride at anchor, contending peacefully for some of the richest commerce of the world.

There is one other particular in which the natural wealth of California surpasses that of any other state. There are more than one hundred mineral springs, that together possess all the remedial qualities that are found in the most notable mineral springs of Europe. Hardly more than half of the whole number that are known to exist in the state have ever had any scientific description. All known minerals that have any healing qualities are held in solution in these waters. Some of these springs have more than local fame for their curative effects. Sulphur, iron, arsenic, and soda are sometimes found in a single group of springs, as at the geysers, where the waters boil and seethe and roar, sending up clouds of steam day and night, as if, after the spent volcanic forces, the bedevilment of nature was prolonged for the entertainment of tourist and stranger. Wherever one may go, in all the length and breadth of the state, the series of striking pictures never fails. Nothing is tame or insignificant; nothing, from the winter bloom of gardens, with all the affluence of color and perfume, to the mountains that are tipped with gold and purple as the sun sinks into the Pacific.

In one other particular California has greater natural wealth than any other state. Not elsewhere in all the Union are there so many climates. No non-resident ever quite gets to the bottom of this mystery. He will read of trains beleagured by snowdrifts in the mountains, and on the same page of almond and orange orchards in bloom; of ice that is cut out in solid blocks on mountain lakes, and of the mercury that marks 75 degrees of heat in some other place; of men in overcoats in San Francisco in July, and of the mercury that has gone up to 100 degrees in some of the interior valleys. The mean temperature of San Francisco for the whole year is 54 degrees, the means for the four seasons being 54, 57, 56, and 50 degrees, a difference of only seven degrees for the entire year. There is a coast climate, an interior valley climate, and a mountain climate, with a great number of subdivisions. Going north ten miles to the small town of San Rafael there is a difference in the summer climate of not less than 10 degrees. Riding for two hours by rail from the coast inland to the San Joaquin valley the difference will

be not less than 35 degrees at midsummer. On the inland side of the Coast range, as in the Santa Clara valley, for instance, the heat of the summer is greater by several degrees than on the ocean side. The ocean, the Coast range, the great interior valleys, and the vast Sierra will account for many of these variations of climate. A well-known author has written a book about "Our Italy" in southern California. Where there are all the climates of Italy and Spain, the resident only encounters the perplexity of choice. There are also the same variations of moisture, ranging for a year from 8 inches of rainfall up to 60 inches, according to the geographical situation which one may choose, and these extremes within the limit of 200 miles.

And better than mountain and valley, and all that goes to make a picturesque state, is that system of public education which is giving instruction to more than two hundred thousand youth, and is crowned by two great universities with doors freely opened to every youth who is qualified to enter. California was admitted to the Union after a long and eventful struggle. Her constitution, framed by men from the North and the South, dedicated the land to freedom. The pioneers had staked their all for law and order as the very corner-stone of an enduring state. Isolated by nearly two thousand miles from the great family of states, the very Stars and Stripes that waved over them gave them a passionate longing for recognition. When the news of admission came, a tumultuous shout went up to the heavens amid jubilant songs and tears. The pioneers who embraced that day knew no country but the Union; nor have they known any other since that day. For forty-five years they have celebrated the anniversary of admission, accentuating it as no other state has done. They have stamped it as a legal holiday—the one day of jubilee wherein love of a particular state takes the higher interpretation of love for the Union. A generation born on the soil rejoices in the designation of "Native Sons" as the richest birthright and heritage that any land can give.

This is California, the Keystone state in the great Empire that is looming up on the Pacific.

THE ECONOMIC ASPECTS OF SOIL EROSION

By Dr N. S. Shaler,

Professor of Geology in Harvard University and Dean of the Lawrence Scientific School

The old view that the earth was firm set and that on it we could build "for aye" has gone the way of many ancient opinions. In every region which geologists have investigated they have had occasion to note many and profound alterations in the form of the surface which have taken place since man has occupied the earth. They have come to recognize the fact that man himself is, through his arts, particularly those of agriculture, one of the great agents of change, and that through these interferences with the course of nature the operation of many forces has been greatly increased in energy. This understanding has extended beyond the class of special students of earth phenomena. We find, indeed, the ablest essay as to the influence of man on terrestrial conditions written by one who approached the subject from the standpoint of the historian. So far as I am aware, no geologist has yet undertaken to consider this matter with reference at once to its scientific aspect and its economic importance. I therefore propose to take up the processes of land erosion from the point of view of the geologist, and to trace the influence of their actions upon the formation and preservation of the soil. In the treatment of this subject we shall be led into that important but as yet unrecognized branch of national economy which relates to the preservation of the tillage values of various countries.

In dealing with any group of geological features, it is well to consider at the outset the origin and mode of application of the energy that has served to give them shape. We may therefore begin our task with a brief account of the forces which operate in the process of erosion. So far as regards their origin, these forces are essentially simple. They all substantially depend upon solar radiation. Only secondarily and in a very unimportant way are they due to subterranean action or to the attractions of the sun and moon, which give rise to the tides. The average amount of heat received by a square foot of the earth's

surface each year is sufficient to lift a pound of matter to a height of many thousand feet. If all this heat could be converted into dynamic energy and applied to rending rock, such as granite, into sand-like material, the effect would be to break up the rocks in a very rapid manner. It is likely that the process of destruction would go on at the rate of several feet a year. Fortunately for the earth, this work is so organized that only a small part of this energy actually enters into the processes which bring about wearing. By far the greater portion is fended off, in ways that we shall have to note, and sent upon other errands.

We shall now consider the ways in which excessive erosion is avoided, and thus be led to see how the remnant of the forces is applied to such work. When the tide of solar energy strikes our sphere, somewhere near one-half thereof is more or less directly intercepted by the atmosphere, and does not penetrate to the lower realm of rock and water, but goes away again into space. Of that which comes to what is commonly called the surface of the earth, again the greater part quickly flies away by radiation into the realms of space. If the air permitted the egress of heat as easily as it does the ingress of that form of motion the earth would never acquire the relatively high and tolerably stable temperatures which make it fit for organic life or for that work of erosion which, as we shall see hereafter, is intimately associated with the existence of all processes of development. If we trust the reckonings of certain eminent physicists, this sphere would under such conditions remain at the temperature of space, or some hundred degrees below zero on the Fahrenheit scale. Owing, however, to a nice adjustment of terrestrial conditions, the air, principally through the moisture it contains, hinders the outward motion of heat a little more than it does its incoming. It is in a small way a trap serving to retain the temperature. Thus the surface is in general maintained in a somewhat warmer state than that of the air. In this interesting condition of affairs we are now to find the origin of those processes which effect erosion.

Owing to the warmth which the sunshine gives alike to land and sea, the atmosphere next those surfaces becomes considerably heated and thereby expanded. This process leads to the formation of an ascending air current, which may be of a local nature, appearing as in dust-whirls, water-spouts, cyclones, or hurricanes, all exhibiting a spinning, upward movement of a temporary and migratory character; or the ascending movement

may take the shape of the great tropical belt of ascending air—that vast, permanent, slit-like chimney which extends almost completely around the earth in the tropical zone. Whether these ascending currents have the character of the spinning storms or the great permanent tropical upcast, their effect is to put the air in motion. Through them volumes of the atmosphere are constantly set into currents of swaying movement, the result being that winds (variable so far as created by the cyclone groups or tolerably constant when due to the tropical upcast) are brought about. These winds, of sufficient energy to have distinct geological value in a direct or indirect way, appear to be constantly at work at all times and at all parts of the earth's surface, except during the long winter nights in the realm about either pole.

The simplest geological work of the winds is that which is brought about by their friction upon the water surfaces of the earth. For our purpose the important result of this friction is the formation of waves or undulations of water, in which are stored the energy which the winds expended in their making. In their greater form these waves may have a length of several miles, a width of a thousand feet or more, and a height from trough to crest of fifty or sixty feet. Such a wave may store more energy than can be applied at one time by the guns of the greatest warship. Gathering their power from a long-continued storm wind, these waves can roll on for hundreds of miles after they have passed beyond the field of air which set them in motion. So long as waves move over a deep sea they have no geological value. The greater part of them die out, generally converting the energy which they represent into heat, that is given to the water or to the air. When, however, the surges enter a part of the sea which is relatively shallow, they begin to do erosive work. In a depth of one thousand feet the higher waves drag a little on the bottom, brushing the sea floor lightly in a manner that may move the finer sediment. At a depth of two hundred and fifty feet the movement is strong enough to sweep small, coarse sand toward the shore, and with each further step in the shallowing the vigor of the scouring action increases until as the wave rises in the wall of the surf the rush has something like the fury of an avalanche, whirling before it everything that is not closely knit to the surface over which it is moving.

As the wave comes into shallow water, and in proportion to the dragging action which it exercises on the bottom, the surge becomes to a certain extent worn out; it shrinks in size, so that

rarely, if ever, do the great waves of the wide ocean attain the continental shores. The decay of the wave is due to the application of its energy to the erosion work which it has done on the sea floor. The loss is shown not so much by the decrease in the height of the surge as in the shortening of its width and the slowing of its motion. A good share of its height is preserved in a peculiar manner: as the undulation comes over the shallowing floor of the sea the hindrance to its ongoing is proportionate to the diminution of the depth. The result is that the front of the wave, being in the least depth, is held back to a greater degree than the rear which is in deeper water. The two sides of the wave are thus crowded together, so that the crest of the arch is relatively uplifted. For all this, however, the wave when it overturns—that is, when the top, or part least held back by the friction on the bottom, shoots over the base and falls in the recurrent cataract of the surf—probably never exceeds twenty feet in height and the energy left in the surging water may be reckoned at less than one-tenth of that which is held by the greater waves of the open sea.

When the wave delivers its finishing stroke in the surf line and its splash front, the modes in which its energy is applied suddenly become changed. The falling mass of water strikes a powerful blow, which, coming upon firm-set rock or sand, has but little effect; but when, as is often the case, the beach is covered with loose stones, these fragments are driven about in a violent manner and strike heavy blows. When the wave overturns, the mass of water sweeps up the slope of the strand, urging before it all the rock fragments which it can drive onward. If the upper edge of the beach is bordered by cliffs, as is generally the case along rock-bound shores, the swash and secondary waves which gather inside the tumble of the surf send the boulders with each stroke to batter the base of the bluff. Although the waves have in all cases lost a large part of their energy before they are able to do this work of battering the shore cliffs they are still, when armed with rock fragments, competent to accomplish a great deal of erosion. Whenever the cliff is composed of ordinary hard rock, the battering at its base cuts a recess, causing the cliff to overhang. In time the weight of the mass which is thus unsupported brings it in ruins to the beach, where the fragments are ground into sand or mud by the action of the waves and removed to the deep sea or the distant reaches of the shore.

Whenever the level of sea and land remains for a considerable time constant and the shore is not protected by sand beaches, the sea cuts a distinct bench into the rocks. Even a few centuries will suffice to make this bench a noticeable feature in the sea front. A single geological period may serve to bring it to a width of one or many miles. In general, however, the frequent, we may say the incessant, changes of level place the shoreline now here and now there on the land surface and so distribute the effect of the marine benching over an area the width of which varies with the steepness of the slope from the interior to the ocean.

It is not as yet possible for us to estimate the value of this erosive work of the waves. Geologists and geographers have of late been disposed to give it less importance than they did in the earlier stages of the science. In my opinion they have seriously underestimated its importance. That it is of much value is clearly shown by the work that has been accomplished along the shores in very recent times. To limit ourselves to coasts that are at the moment steadfast and to areas within the limits of the United States, we may instance the southern borders of the islands of eastern Massachusetts, which since the settlement of the country have been encroached upon by the sea at a very rapid rate. On the south side of Nantucket the waste in certain years has amounted to five or six feet. On the corresponding shore of Martha's Vineyard the recession during the last forty years (as has been shown by the surveys of Assistant H. L. Whiting, of the U. S. Coast Survey) has been at an average rate of three feet per annum. It is probable that the gain of the sea on this part of the coast during the three centuries since the land was first seen by Europeans has amounted to nearly a mile.

On ordinary rock shores the rate of wearing is relatively slow and exceedingly variable in amount, but where the waves have a fair chance to assault the land it is always considerable. Allowing the minimum results obtained in numerous observations, we must reckon the gain of the sea at a mean of two feet per century. Computing at ten thousand years, the time that has elapsed since the ice-sheet of the last glacial period passed from these shores, the total amount of this coast erosion should average two hundred feet. During a period of one hundred thousand years—a very brief age in the history of the world—the sea should have worked its way in more than a third of a mile. Since the beginning of Tertiary time, which cannot well

be reckoned at less than two to three millions of years ago, the recession of the shore, due to the action of the waves, may safely be estimated at several miles. Taking all the coastline on the eastern border of the United States into consideration, we see that the sand beaches, owing to their singular endurance of wave-action (a feature I have discussed elsewhere), have an important restraining effect on the process of marine erosion. Making allowance for this protective work, it remains clear that the effect of ocean waves is to wear back the shorelines into the land, and this at a rate which in a geological sense may be termed rapid.

As geologists find but few shores bordered by distinct benches cut in the hard rocks, they have generally underestimated the value of wave-work, but in forming their opinion they have neglected the important fact that the continents are continually changing their positions in relation to the sea level. Every step in the advancement of our knowledge of the problem shows that the shore lands are ceaselessly and at times suddenly moving upward or downward. Even those coasts which now appear to be steadfast have in very recent times changed their positions by sinking or rising. The result of these perpetual swayings of the coastlines is to distribute the benching action of the waves over a wide zone, extending along the most of the great lands from a level much below that of the present shores to a position far higher than that which they now occupy. In some instances, where the sea has chanced to remain for a long time in contact with the land on one horizontal plane, we note the existence of broad shelves of rock extending outward from the sea-cliffs, sometimes to the distance of a mile or more. Thus, on the coast of Yorkshire, from Whitby southward, a sea-cut bench, with its surface just above low tide, stretches seaward from the foot of the towering cliffs for an average distance of more than a mile, attesting in the plainest possible manner the cutting power of the sea. In general, we may say of the eastern coasts of North America that indications of marine work are visible to a height of several hundred feet above the plane of the ocean, and that there is good reason to believe that such cutting work has been done on much of the slope which now lies below the sea. When by the uplifting of the land ancient sea bases are carried above the limits of wave-action they are quickly worn away by the processes of erosion which are proper to the land. When such benches are lowered beneath the ocean they are soon covered by sediments, and thus brought into positions where even subse-

quent uprising of the continent would not cause them to be revealed.

Along the eastern face of North America, from South Carolina to Newfoundland, there exists a series of old mountain ranges, to which we may give the name of the Lost Appalachians, that have been worn down to their roots by some process of erosion. West of these deeply wasted mountains in the section from Pennsylvania southward we have the yet older ranges of the Blue Ridge or Central Appalachians, which on their eastern face have been worn away, though their western parts retain a considerable relief. Still further to the west, behind the wall of the Middle Appalachians, lie the West Appalachians or Cumberland and Alleghany ranges. These last-named elevations retain their original reliefs much more perfectly than the seaward mountains; they are relatively little degraded. They are recognized as mountains in common speech, while those along the Atlantic coast, though of younger age, have lost to the common eye their mountainous character and are known to the geologist only by the altitudes of their rocks.

Considering from the point of view of economic interests the erosion or land destruction which is accomplished by the sea, we note that even in historic times it has wrought changes of considerable moment to mankind. Wherever the shores are bordered by very hard rocks or walled-in by sand beaches, the processes by which the land is stripped away and its debris carried into the sea are slow; the destruction is distributed over a long period, and there is no distinct effect in the interest of men. Where, however, the coasts are of soft rocks, the waste is often so rapid that it may dispossess communities of their inheritance. Thus, at the rate of marine invasion which is now going on on the southern shores of Nantucket, that island is likely to disappear in the course of two or three thousand years, being in the end reduced to the condition of a shoal such as we now find in the shallows which stretch far to the southeastward of that island, shallows which seem to mark the position of ancient lands that have been swept away by the waves. George's shoals and other shoals extending along the coast to the northern end of the banks of Newfoundland can best be explained by supposing that they mark the sites of islands that have been planed down by the sea.

The recorded history of this country is too brief to afford any very important instances of marine erosion. In the Old World,

however, these abound. Perhaps the most noteworthy is that of the politically important island of Heligoland in the North sea, which is wasting with such rapidity that it is not likely to endure for more than two or three centuries to come. The eastern and southern coasts of England, bordered as they are by soft stratified rocks, are also the seat of a rapid though locally variable marine erosion, which within the limits of recorded history has sensibly diminished the areas of many parishes. Accurate data for determining the number of square miles thus lost to the service of man are lacking, but from a careful inspection of the English coast I am of the opinion that during the Christian era the total loss of area in that portion of the most important island in the world has probably been not less than one hundred square miles. As the land thus destroyed was of average fertility, the loss of food-giving capacity has been sufficient to diminish in a noteworthy way the population-sustaining value of the country.

Against the invasions of the sea, whether they arise from the direct assaults of the waves and the currents which the winds produce or by a combination of subsidence and wave-action, there seems to be no effective means of protection. The skill of the engineer, applied at great cost, may arrest or delay the loss at points where the safety of harbors or towns is involved, but there is no reason to suppose that it will ever be found economical to protect the sea margin from wasting where the defenses are merely to save agricultural land. Our own coasts, particularly that of New Jersey, are strewn with wrecks which mark the failure of ill-directed efforts to ward off the persistent assaults of the waves. At certain points in eastern Massachusetts I have found it worth while to advise the owners of houses on the seashore where their ground was endangered by the inwashing of the shoreline to heap the sea front with large boulders drawn from the neighboring fields. In somewhat protected positions the waves breaking on this artificial beach are fended from the cliffs. Thus by giving the sea-dogs a bone they could for a time be kept from their ravages. Where the waves do not attain the coastline with a height of more than five feet, this inexpensive barrier appears to be very serviceable, but on the more open shores any boulder that could without great cost be placed on the shore would be tossed about and rapidly worn to small bits. For the maintenance of the precious land, that seat of all the higher life of the world, against the assaults of the waves or the more rapid destruction which is brought about by the down-

sinking of the shore lands, we must look to those natural forces which are ever, though not uniformly, at work uplifting the continental arches above the plane of the seas. At present we seem to be in a period where the great lands recently in a state of very general depression as regards the sea level have come to a prevailingly steadfast state. The next step may be toward a general gain of the continental areas on the fields of the oceans.

We turn now from the work of erosion which goes on upon the shores, and which, as we have seen, is due to the action of solar heat working through the movements that it enforces on the atmosphere, to another effect of the sun's energy, that due to the evaporation and precipitation of water. We have noted the fact that the radiation of heat is hindered by the atmosphere, one consequence of which is the warming of the air next the earth's surface, an effect which is noticeable in a diminishing rate for a great height above the surface. To this action is also attributable the establishment of conditions which bring about the system of the rains. It fortunately happens that the adjustment of temperatures next the earth's surface makes it possible for the process of evaporation to lift a large amount of water into the air. The quantity thus borne upward is not as yet definitely ascertained, but it probably amounts to not far from an average of five feet per annum over the surface of the seas. The greater part of this water after ascending to a height of perhaps a mile or more, on an average, is condensed and falls back to the ocean as rain or snow. In making this circuit work is done, but it is of no geological value. Following the dynamic history of a pound of water in its up and down journey, we see that it takes five thousand foot-pounds of energy expressed in heat to lift it for the mile or so of its ascent, and that this energy is reconverted into heat by the friction which the water encounters in falling or by the blow which it strikes when it attains the surface. Owing to the conditions, the energy of position which the water had when at its highest point (an amount sufficient to lift one ton to the height of two and one-half feet) has, when it falls back to the sea, done no work of lasting importance. It is, as we shall see, quite otherwise when in the downward movement the water falls upon a land surface.

The winds—those movements of the atmosphere which create the waves and thus bring about marine erosion—transport the watery vapor from its main source, the seas, so that a share of it, perhaps near one-half of all that is formed, is brought over

the surface of the lands. There, owing to the fact that the air is more or less uplifted, the precipitation of the water vapor is more favored, and the proportion of rainfall is usually greater than it is upon the surface of the ocean. Falling upon the land, the condensed moisture comes down in one or another of three forms—as dew, as rain, or as snow. The dew, though it has much geological importance because of its relation to plant life, has only indirect value in the problem of land erosion. It serves to diminish this wearing by favoring in the dry seasons the development of a mat of vegetation which in the period of rains protects the earth in a very effective way from the temporary streams which gather during heavy showers. The importance of this form of precipitation is great, but it is so limited that we may, with this brief statement, dismiss it.

The normal form of falling water is rain. In this mode of precipitation we usually find the fluid descending from a considerable height in the form of drops of varied bulk, averaging perhaps rather more than one-twentieth of an inch in diameter. They are generally large enough to acquire a considerable velocity on their way to the earth, though their momentum is much diminished by the friction they encounter in passing through the air. Striking the earth, they apply to it what energy they have by virtue of their velocity. If we observe what takes place on recently tilled earth, we readily note certain important consequences arising from this immediate assault of the rain. As soon as the soil is moistened, each stroke acts to break up the clods, bringing the material into the condition of mud, in which it is readily borne away by the rills which, if the shower be heavy, quickly form in such numbers as to interlace the surface. In a few moments these little streams, at first obscure, gather into distinct rills, which, with quickly swinging curves, carve out a model of a new drainage system. In the course of an hour of very rapid downfall a bare, plowed field, on a declivity of not more than five feet in the hundred, or less than the average slope of land, may have an average of one-third of an inch of its surface soil removed to the channels of the streams which drain it. It may, after such a time of rain, be noted on a field which has been plowed and rolled that here and there a small flat stone or a potsherd lies on top of a little earthen column. We see at once that the natural roof has protected the earth beneath and caused it to be left behind in the process of erosion which has overtaken the soil of the neighboring surface.

A brief comparison of the effect of a heavy rainfall on a newly tilled surface bare of vegetation and on a like area which is protected by the natural covering of living and dead plants will show the peculiar influence of the vegetable shield on the history of soils. On wood and grass lands the rainfall has practically no erosive action whatever. In the forests the mat of decayed vegetation is in most cases able to take in three or four inches of water, which it yields up so slowly as to distribute the flow over weeks and in such a manner that it removes not a bit of the soil. On the meadows the outgoing of the water is more rapid; it may, indeed, pass to the permanent streams quite as rapidly as from the plowed ground, but it is kept from contact with the soil by the closely set and entangled stems through which it cannot break, even when gathered into considerable streams. Unless field mice or moles have made burrows leading up and down the slopes and thereby providing a way in which the water is able to work below the grass, a rainfall of two inches an hour, a rate which may be called torrential, may be carried from a large field of well grassed land having a slope of twelve feet in a hundred without notably eroding the soil.

If I were an extreme selectionist I should probably not hesitate to attribute to their own agency, as developed by survival of the fittest, the admirable system by which the plants preserve the soil on which they depend from the rapid degradation to which it would be subjected but for this defense. The protective work which is here accomplished is indeed more perfect than elsewhere. It may be conceived that the plants have prospered in proportion to the efficiency of the shield which they afford to the soil on which their life depends. Interesting as is this question, it lies apart from our inquiry, and we must turn our attention to the further history of the rainwater.

(To be continued.)

THE NANSEN POLAR EXPEDITION*

Special Report of the Hon. Ernest A. Man,

United States Consul at Bergen

On the 17th day of June, 1896, as some of the men of the English Jackson and Harmsworth expedition, in Franz Josef land, were looking out over the ice they discovered a weird figure advancing towards them, with long straggling hair and beard and garments covered with grease and blood stains, who proved to be none other than Dr Fridhjof Nansen, who fifteen months previous had left his ship, the *Fram*, at 83° 59′ north latitude and 102° 27′ east longitude in order to push on with sleds, boats, and dogs towards the Pole. In a shelter some distance off was Dr Nansen's companion, Lieutenant Johansen.

A few weeks later the *Fram* arrived safely at Skjervö, Norway, some days after Nansen's return home. While Nansen did not reach the hoped-for goal, the results of the expedition promise to be of value to the scientific world and of inestimable assistance to future efforts in the same direction.

The *Fram*, with a company of thirteen men, left Vardö, Norway, the 21st of July, 1893, and proceeded eastward through the Kara sea, rounded cape Chelyuskin, and on the 15th of September was off the mouth of the Olenek river. There they expected to go in to obtain additional dogs, but, finding that owing to the shoals and rocks and lateness of the season they would probably get locked in the ice and thus be delayed a year, they at once took a northerly course into the open Arctic ocean until September 22, when at 78° 50′ north latitude and 133° 37′ east longitude they made the vessel fast to an ice-field. From this point they began drifting with the ice in a northerly and northwesterly direction, according to the plan laid out by Nansen, and by which he hoped to drift near or over the Pole, as was supposed to have been the process by which the effects of the *Jeannette* expedition reached the eastern coast of Greenland.

As had been anticipated, the drift was most rapid in the winter and spring. During the summer months they were hindered

* This report, transmitted from Bergen September 4, has been courteously placed at the disposal of the National Geographic Society by the Hon. W. W. Rockhill, Acting Secretary of State.

by the prevailing north winds. They continued drifting with the ice in this manner for nearly eighteen months, when, having reached on March 3, 1895, 84° 4′ north latitude, and finding they were drifting to the southward again, Nansen determined that the time had come in which to leave the ship and make the attempt to reach the highest possible north by other methods—a decision in which he was perfectly justified, as the *Fram* was even then at a more northerly point than had been attained by any previous expedition.

Having given the command of the *Fram* over to Sverdrup, who had been his companion on his Greenland expedition, and accepted the offer of Lieutenant Johansen, who volunteered to accompany him—though warned by Dr Nansen that it was at the risk of his life to do so—the two men, on the 14th of March, 1895, at 83° 59′ north latitude and 102° 27′ east longitude, left the ship. They took with them 28 dogs, 3 sleds, 2 kayaks or canvas-covered canoes, food for the dogs for thirty days, and provisions for themselves for three months. From the 14th of March until the 7th of April they struggled onward, making their way on snowshoes or drifting on ice-floes, either northerly or southerly, with loose ice driving up around them into formidable heights over which it was wellnigh impossible to transport the boats and sleds, and with the thermometer almost steadily at 40° below zero, Fahrenheit.

On April 7 the odds against which they were laboring became decisive; there was no prospect of scaling the ice-barriers around them. They were then at 86° 14′ north latitude. Dr Nansen put on his snowshoes and took a last reconnoitering tour to the northward. As far as the eye could reach lay great bodies of ice driving before the wind, with no land or any indication of the same perceptible. It was apparent to Nansen that under these circumstances, and with the number of their dogs already decreasing, they had proceeded as far as it was practicable, and he therefore decided that they would start upon their return journey, taking a southerly course toward Franz Josef land, intending to proceed from there to Spitzbergen, where he knew they would be sure to find a ship which would carry them home.

They set forth on the 8th day of April, 1895, and on the 12th their watches stopped, which of course threw them out of their longitudinal reckoning somewhat, but they bravely went on, overcoming the most discouraging obstacles, sometimes gaining long distances on their snowshoes, and again drifting with the

ice several miles back to the northward. Toward the last of June they concluded to make a sort of camp and wait for the ice to break up somewhat. Their food was giving out and they had but two dogs left, so they began to depend on walrus and bear meat for their sustenance. It was a month of hardships, but on the 23d of July they pushed on again. with health unbroken, toward land, which they sighted the next day, July 24, at about 82° north latitude.

At that time of the year the ice was considerably broken up, and, as it was unsafe in the boats, they were obliged to travel over the floating ice, leaping from one ice-field to another, and in this difficult and dangerous way proceeded towards the land they had sighted, and which was reached the 6th day of August, at 81° 38′ north latitude and about 63° east longitude, and proved to be three snow-covered islands, to the west of which they found open water, and through this they made their way in a westerly and southwesterly direction until August 26th, at 81° 12′ north latitude and about 56° east longitude, when they set foot upon land—Franz Josef land—where Dr Nansen considered it advisable to prepare themselves for spending the dark winter months, as it was too late to continue the journey to Spitzbergen. Thus they had been more than five months wandering over the Arctic ice-fields and in the Polar sea without a roof to cover them, even without furs, which they had left in order to limit their impedimenta to the strictest necessities.

The hut they put up was constructed of stone and turf, covered with walrus skins, and was twelve feet long and six feet wide, with a door made of bear skin. Here they spent nine dreary months, depending upon their own efforts for food, as their last dog had been killed before they reached land. They had started with twenty-eight dogs, but as soon as the provisions for them gave out they had to kill the weakest, one after another, in order to feed the remaining pack.

During this terrible winter bear meat was their main dependence—in fact, these two men shot nineteen bears during their adventurous fifteen months. The fat was used both as fuel and light, a lamp having been constructed out of the metal work of the sleds. They were also obliged to make themselves sleeping bags and winter clothing of furs.

On the 19th of May, 1896, the days having become sufficiently bright, and with a supply of bear meat and the hope of finding some game on the way and making a speedy journey homeward,

they set out for Spitzbergen. On May 23d they came to open water, at 81° 5′ north latitude, but were delayed by a heavy gale until the 3d of June. They saw a large body of land in the west, with open water spreading out to the north and west of it, but they concluded to go over the ice to the southward, into a broad unknown strait. When they reached the southern end of this strait they found the open sea to the westward. It was while struggling over the ice off the coast of this land that they came upon the Jackson-Harmsworth expedition, which happened on the morning of the 17th of June, 1896. It was Nansen's turn to cook that day, and he had risen early to get breakfast, while Johansen lay in under the shelter they had constructed of the two kayaks and the sails of their sleds. Suddenly Nansen called out, "I hear the barking of dogs; there must be people near." Johansen sprang up, but could hear nothing. In the meantime they decided to finish their meal, and then Nansen went forth to search for the source of the sounds he had heard. He had not been gone long when Johansen distinctly heard the barking of dogs himself, and not long thereafter a party of men from the Jackson expedition made their appearance. They prepared at once to take Johansen and the camping effects with them to the Jackson headquarters, where Nansen had preceded them. Among the articles they took with them were the kayaks, or flat-bottomed canvas boats, which had carried the two men for so many days. They were made of a frame of bamboo, covered with sailcloth. One boat had been made by Nansen and the other by Mogstad, the carpenter on the *Fram*. They weighed some twenty pounds each, and were about twenty feet long, completely decked over, with a hole in the middle for the rower, and in each end a smaller opening through which to get at the provisions and anything else stowed under the bows and stern. These boats were now perfectly black with the grease and oil which had been smeared over them continually to keep them water-tight. Besides the boats, there were the sleeping-bags, old and ragged, their snowshoes, paddles, guns, bear-skin traces for dragging the sleds, etc. Their only cooking utensil was exceedingly primitive, and in the bottom of it were left the remains of the last meal cooked in it, a sort of soup, made of salt water, the meat of a young walrus, and a little corn meal. It is said that it would be impossible for the civilized world to picture to itself the appearance of Nansen and Johansen as they stood before the English explorers, their beards long and unkempt, their hair

hanging in wild disorder upon their shoulders, and their clothing stiff and dark with the accumulated grease and blood of the animals they had slaughtered and cooked during fifteen months of unexampled existence.

On August 13, 1896, the Jackson expedition's ship, the *Windward*, landed them at Vardö, Norway, and on the 20th of the same month the *Fram* came steaming into Skjervö, near Hammerfest, and thus the whole expedition was once more on its native shores, every man alive and hearty, and the *Fram* itself without a timber injured.

After Nansen left the *Fram* in Captain Sverdrup's charge it continued its, on the whole, northwesterly drift, sometimes veering a little to the southward, and then gaining something in the wished-for direction northward, and again lying cradled in ice, from which it was several times freed by charges of powder, sometimes as large a charge as 110 pounds being exploded in the ice.

On the 16th of October, 1895, seven months after Nansen left them, the *Fram* reached her highest latitude, viz., 85° 57′ north latitude, in longitude 66° east. After this the drift was to the southward again, and when the ice broke up this summer of 1896 the most energetic efforts were made to free the *Fram* and get her through the vast fields of ice out to open water. This was finally successful, and on the 13th of August, the very day of Nansen's arrival at Vardö, the *Fram* reached the open sea, with no more obstacles between her and a home port. No one had been ill or injured during the voyage and not a case of scurvy had occurred. Cheerfulness reigned, and the amusements with which the long, dark winters were beguiled were only disturbed now and then by a feeling of anxiety caused by the crunching and grinding of the masses of ice crowding against the ship's sides. The electric light, with its windmill and accumulators, was a great success. When the wind failed, the men were ready and willing to take needed exercise by turning the capstan, and thus supplying the deficiency. No land was seen above the 82° of latitude. During the *Fram's* voyage soundings from the north of the New Siberian islands to north of Spitzbergen showed the minimum depth to be 1,600 fathoms and maximum 2,000 fathoms, which upsets all theories as to a shallow Polar basin in the European Arctic ocean. One peculiar feature of this Polar sea is that the upper space of water to a depth of about 100 fathoms is ice cold, while below it there is a stratum of water showing a half degree of warmth (Celsius) and reaching to a depth of about

380 fathoms, below which it is again cold. This may, possibly, be owing to the Gulf stream. There was a great dearth of organic life, none whatever being found in the greater ocean depths, and no signs of animal life in the higher latitudes, excepting an occasional migratory bird, so that the idea of organic life prevailing in the upper regions about the Pole is erroneous.

While many contend that Nansen's theory of a Polar current flowing across the Pole on to the east coast of Greenland seems to have been correct, there are strong arguments against it, and Sverdrup, who was in command of the *Fram* when she made her most northerly record, seems to think that there is no regular current, but that the movements of the ice masses are mainly governed by the winds. On the other hand, from a look at the chart showing the entire drift of the *Fram*, there would seem to be a reasonable probability that if the *Fram* had taken the course originally intended by Nansen, viz., had gone farther to the eastward and entered the ice-fields to the northeast of the New Siberian islands instead of the northwest, she might have drifted farther north, if not over the Pole itself. However that may be, it is said that Dr Nansen himself has stated that should he undertake another expedition in that direction it would not be by means of a ship, but with sleds, kayaks, and dogs, with Franz Josef land as a starting-point, and depending mainly on the resources of the regions about him for subsistence.

Whatever may be thought of the wisdom and usefulness of such expeditions, all must admire the superior courage of these two Norwegians, and especially Dr Nansen, who, fully appreciating the full extent of the deadly perils they were to encounter, had also the sagacity and ability to foresee and prepare for almost the minutest details of their undertaking. The fact of these men, after having passed through the terrible rigors of two Arctic winters, stepping over the side of their sheltering ship into the unknown wastes of this high latitude, with no expectation of rejoining her there, and marching with their dogs straight into the terrible north, required an amount of splendid courage impossible to excel; and that they were able to live through fifteen months of these conditions shows a physical superiority as great as their daring, in which, no doubt, their well-known abilities as sportsmen and athletes was a very important factor.

ICE-CLIFFS ON THE KOWAK RIVER

By Lieut. J. C. Cantwell,

United States Revenue-Cutter Service

The Kowak river rises in the northwestern part of Alaska, and after a tortuous easterly course of about 550 miles, the greater portion of which is within the Arctic circle, it flows into Hotham inlet, a large body of fresh water opening into Kotzebue sound. During the summers of 1884–'85 it was my good fortune to visit this region and to make a reconnaissance of the stream from its mouth to its headwaters. Among the many novel and interesting features of the region, which had never previously been visited by white men, none were more striking than a remarkable series of ice-cliffs observed along the banks of the river about 80 miles from its mouth. These deposits of ice were first seen in some of the low silt banks of the delta, and it was supposed that they were the result of the spring freshets in the river forcing large masses of ice into the soft, yielding soil of the banks. But when on our emerging from the delta and reaching the higher land of the interior we still found these ice deposits in the form of cliffs, from 80 to 150 feet high, the theory of current formation had to be abandoned. The banks of the stream in the region where the ice-cliffs are found are not all filled with ice, and the water-marks on those which are composed only of soil and rock show beyond question that the water has never reached a sufficiently high stage to have transported the ice to its present position.

At two points the cliffs attain an altitude of over 150 feet, and one cliff measured by sextant angles showed 185 feet. The tops of all the cliffs were superposed by a layer of black, silt-like soil from 6 to 8 feet thick, and from this springs a luxuriant growth of mosses, grass, and the characteristic Arctic shrubbery, consisting for the most part of willow, alder, and berry bushes, and a dense forest of spruce trees from 50 to 80 feet high and from 4 to 8 inches in diameter.

Where the face of the cliffs was towards the south the upper portion of the formation would be found undergoing the process of destruction under the melting action of the sun's rays, while in other situations the erosion of the river current was constantly

undermining the cliffs. Both of these destructive agents caused great masses of soil and tree-laden ice to become detached and fall into the stream. Where the retreating waters of spring had left these masses of detached ice stranded on the adjacent beaches or bars, piles of soft dust almost entirely free from any gritty substance would be left as a monument to mark the spot where the ice had been melted by the summer sun. These small dust heaps are a characteristic feature of the region where the ice-cliffs are found and are entirely different in appearance from the gravel and sand heaps deposited in the same way by ice floated down from the upper river.

An examination of the tops of the ice-cliffs was very difficult on account of the dense undergrowth and the thick carpet of moss, but on one we discovered a lake about a mile in diameter and situated some 500 yards from the face of the cliff. The water in this lake was fresh and clear, but upon being disturbed became exceedingly turbid, owing to the presence of a large quantity of fine, decayed vegetable matter on the bottom. A piece of the ice melted showed a residuum of fine, impalpable dust, which under a lens proved to be composed mainly of vegetable matter and, while fresh, emitted a very pungent, disagreeable odor.

The country in this region is mostly rolling tundra plains, with innumerable small lakes and streams, all of which are tributary to the larger river. There is no evidence of glacial action whatever, and it is not until the first mountain range is reached, a hundred miles further upstream, that any rocks *in situ* are seen. Here and further inland more plainly are to be found beds of trap, which an examination shows to be a pronounced olivine diabase, with such minerals as hornblende, mica, feldspar, augite, etc. present. Other rock forms show unmistakable evidence of the eruptive agencies that have been at work in the formation of the upper river region. The formation of the remarkable ice-cliffs in the lower country is, however, a geological nut which the writer admits his inability to crack.

General A. W. Greely discusses the Nansen Polar Expedition at considerable length in Harper's Weekly of September 19, eulogizing Dr Nansen's courage and self-reliance, but taking strong exception to his leaving the *Fram*.

RECENT HYDROGRAPHIC WORK

The work of the Division of Hydrography in the United States Geological Survey has been greatly extended, owing to the increased appropriation made by Congress last spring. The reports covering the first quarter of the present fiscal year—July to September, 1896, inclusive—show that a large amount of data of more or less value to geographers is being accumulated. This relates principally to the rivers of the Rocky Mountain region, of the Pacific coast, and of the Atlantic slope. The underground waters also are being systematically studied, the problems being largely geologic in character. In particular, the work of Mr Willard D. Johnson upon the underground waters of western Kansas should be noted. Mr Johnson has been carrying on his examination mainly in the vicinity of Garden City, Kansas, where he has put down a number of test-wells for observing the fluctuations of the ground waters. By causing the large steam-pumps of the city water works to be operated at various rates of speed the ground water has been drawn upon, and he has been able to make valuable observations upon the rate of flow and general behavior of these percolating waters. The lack of uniformity in the data shows clearly that the problem of the movement of ground water is by no means so simple as it appeared, and that a large amount of detailed work is necessary. The importance of a correct knowledge of this subject can best be appreciated when it is considered that the utilization of a large part of the most fertile lands of the west is dependent upon the practicability of pumping water from under ground for irrigation.

The investigations above mentioned are, however, but a part of those of the Division of Hydrography. In eastern Washington and adjacent portions of Idaho and Oregon Professor Israel C. Russell has carried on a reconnaissance of the artesian conditions; in North Dakota Professor Earle J. Babcock has been making examination of the water supply derived from wells and springs; in Nebraska Mr N. H. Darton has been making a systematic study of the areal geology of the vicinities of Lincoln and Grand Island for the purpose of obtaining detailed information regarding the underground waters, and Professor Erwin H. Barbour has been carrying on a broad study of the wells of the

state; in Kansas Professor Erasmus Haworth has been giving particular attention to the artesian conditions in the vicinity of the Meade County flowing wells, and in the Ohio valley Mr Frank Leverett has been continuing his study of water supply in connection with the examination of the glaciated area. About twenty-five short papers are now in preparation relating to the water supply in various parts of the United States or to the utilization of this in irrigation or for power or domestic purposes.

F. H. N.

MISCELLANEA

The September number of the United States Consular Reports, to which admirable publication of the Department of State The National Geographic Magazine is frequently indebted, contains valuable geographic articles on the Kongo Free State, Hangchow, and the Production of Coffee in Mexico.

The library of the National Geographic Societ[illegible] has again been enriched through the munificence of the Hon. Gardiner G. Hubbard, president of the Society, who has presented to it an unbroken set of Nouvelles Annales des Voyages from its commencement in 1819 to 1865, inclusive. These 184 volumes cover the world's explorations for nearly half a century and constitute the most valuable geographic serial extant.

The various subsidies granted by Congress for special fast mail service are of advantage to the public not merely in the acceleration of the mails, but also in the increased facilities the different railroad companies are enabled to offer in the transportation of passengers. Especially is this the case with the Southern railway, the subsidized mail trains of which system, running 100 miles or more without a stop, now reach the principal points in the South in several hours' less time than has ever before been practicable.

It is proposed to erect in London a terrestrial globe having a diameter of 84 feet and showing the earth's surface on a scale of about eight miles to the inch. Every geographical feature of importance will be shown and named. The United States, from east to west, will measure about 30 feet, and India, from east to west, about 23 feet, while London, drawn to scale, will cover a space rather larger than that of a silver half-dollar. Rarely has a project called forth a more remarkable manifestation of interest and approval than this has evoked. Among the 350 men eminent in art, science, and literature who have given it their hearty support are Markham, Stanley, Geikie, Lockyer, Bryce, Lecky, Wallace, Flower, Crookes, Keltie, and many others equally well known on both sides of the Atlantic. The project should prove of the greatest educational value and it cannot be too highly commended.

XUM

The National Geographic Magazine,

NOW PUBLISHED MONTHLY,

numbers among its contributors the following well-known writers on the different branches of geographic science:

Mr. Cyrus C. Adams, New York.
Dr. Cyrus Adler, Smithsonian Institution.
Mr. Marcus Baker, U. S. Geological Survey.
Capt. John R. Bartlett, U. S. N.
Dr. Francis Brown, Union Theol. Seminary.
Hon. Jefferson B. Browne, Collector of Customs at Key West.
Dr. E. L. Corthell, C. E., New York.
Dr. Elliott Coues.
Hon. William E. Curtis, ex-Director of the Bureau of the American Republics.
Mr. Frank Hamilton Cushing, Bureau of American Ethnology.
Dr. Charles W. Dabney, Jr., Assistant Secretary of Agriculture.
Dr. Wm. H. Dall, Smithsonian Institution.
Dr. George Davidson, President of the Geographical Society of the Pacific.
Mr. Arthur P. Davis, U. S. Geological Survey.
Mr. Wm. M. Davis, Professor of Physical Geography in Harvard University.
Dr. David T. Day, Chief of the Div. of Mining Statistics and Technology, U. S. Geol. Sur.
Mr. J. S. Diller, U. S. Geological Survey.
Hon. John W. Foster, ex-Secretary of State.
Mr. Henry Gannett, Chief Geographer, U. S. Geological Survey and 11th Census.
Mr. G. K. Gilbert, U. S. Geological Survey.
Gen. A. W. Greely, U. S. A., Chief Signal Officer, War Department.
Hon. Gardiner G. Hubbard, President of the National Geographic Society.
Dr. Mark W. Harrington, President of the University of the State of Washington.
Lieut. Everett Hayden, U. S. N., Secretary of the National Geographic Society.
Mr. Robert T. Hill, U. S. Geological Survey.
Mr. Wm. H. Holmes, Dir. of the Dept. of Anthropology, Field Colum. Museum, Chicago.
Dr. Emil Holub, Vienna, Austria.
Dr. Sheldon Jackson, U. S. Commissioner of Education for Alaska.
Mr. Willard D. Johnson, U. S. Geol. Survey.
Mr. Mark B. Kerr, C. E.
Mr. George Kennan.
Prof. William Libbey, Jr., Princeton Coll., N. J.
Prof. E. McClure, University of Oregon.
Prof. W J McGee, Bureau of American Ethnology.
Mr. John E. McGrath, U. S. Coast Survey.
Admiral R. W. Meade, U. S. N.
Dr. T. C. Mendenhall, President of the Polytechnic Institute, Worcester, Mass.
Dr. C. Hart Merriam, Ornithologist and Mammalogist, U. S. Department of Agriculture.
Hon. John H. Mitchell, U. S. S.
Prof. W. L. Moore, Chief of Weather Bureau.
Mr. Frederick H. Newell, Chief Hydrographer of the U. S. Geological Survey.
Mr. Herbert G. Ogden, U. S. Coast Survey.
Lieut. Robert E. Peary, U. S. N.
Mrs. Robert E. Peary.
Hon. Geo. C. Perkins, U. S. S.
Mr. William H. Pickering, Professor of Astronomy in Harvard University.
Major John W. Powell, Director of the Bureau of American Ethnology.
Prof. W. B. Powell, Superintendent of Schools, District of Columbia.
Hon. John R. Procter, President of the U. S. Civil Service Commission.
Mr. Israel C. Russell, Professor of Geology in the University of Michigan.
Dr. N. S. Shaler, Professor of Geology in Harvard University.
Commander Charles D. Sigsbee, Hydrographer to the Bureau of Navigation, Navy Dept.
Miss Eliza Ruhamah Scidmore.
Commander Z. L. Tanner, U. S. N.
Mr. Frank Vincent, New York.
Hon. Charles D. Walcott, Director of the U. S. Geological Survey.
Mrs. Fannie B. Ward.
Mr. Bailey Willis, U. S. Geological Survey.

---

25 Cents per Number or $2.50 per Year.

Among the Contents of Forthcoming Numbers of

THE NATIONAL GEOGRAPHIC MAGAZINE

WILL BE THE FOLLOWING:

A Winter Voyage through the Straits of Magellan,

BY ADMIRAL R. W. MEADE, U. S. N.;

Egypt and the Recent Expedition to Dongola,

BY COLONEL CHARLES CHAILLÉ-LONG,

LATE OF THE GENERAL STAFF OF THE EGYPTIAN ARMY;

The Negro Republic of Africa and its Homes,

FROM PERSONAL OBSERVATION,

BY MR GEORGE C. FRENCH;

The Physical Features of Lake Superior,

BY DR MARK W. HARRINGTON,

PRESIDENT OF THE UNIVERSITY OF THE STATE OF WASHINGTON;

—— AND ——

The Utilization of the Vacant Public Lands,

BY JUDGE EMORY F. BEST,

ASSISTANT COMMISSIONER OF THE GENERAL LAND OFFICE.

JUDD & DETWEILER, PRINTERS, WASHINGTON, D. C.